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P15502

2. Patent application number
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Patents ADP number *(if you know it)*

If the applicant is a corporate body, give the country/state of its incorporation

1) BRITISH VIRGIN ISLANDS

4. Title of the invention

A HEATER

5. Name of your agent *(if you have one)*

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

Edward Evans & Co.
Clifford's Inn
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London EC4A 1BX

Patents ADP number *(if you know it)*

661001

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

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Number of earlier application	Date of filing *(day / month / year)*

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Continuation sheets of this form	
Description	11
Claim*(s)*	4
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A HEATER

The invention relates to a heater, particularly to a heater for a liquid crystal display or LCD.

Liquid crystal displays are extensively used in many applications. As will be understood, the liquid crystal layer acts as a light modulating mechanism controlling light transmission or reflection. This light modulating mechanism can be controlled electrically. The response time of the liquid crystal materials used in LCDs is usually temperature dependent, especially for more viscous liquid crystal fluids. For example, the response is very sluggish and slow when the temperature is low. Some way of regulating the temperature is required. When the surrounding temperature is too low, some heat has to be pumped in to bring the temperature of the device to a reasonable value. This can be in an external way, where the display is in a temperature controlled environment.

This arrangement is expensive as the whole environment has to be brought to a desired operating temperature for the LCD, and can also be difficult to control in any event.

It is accordingly an object of the invention to seek to mitigate these disadvantages.

According to a first aspect of the invention there is provided a heater for electrical or electronic components, comprising a substrate to which is applied a layer of transparent conductive material and

electrodes secured electrically conductively thereto over the width thereof and extending therebeyond for connection with a source of power.

Thus using the invention it is possible to provide a generation of heat internally of an LCD display.

In practice, some "warm up" time can be allowed for the heater to heat up the whole display to a desired temperature.

The conductive material may comprise a layer of indium tin oxide (ITO) applied to the substrate, which may be orthogonal. This provides a simple yet effective heater.

There may be two electrodes one at a respective opposite side of the layer and secured thereto by a conductive adhesive. This again provides a simple yet effective heater, particularly when the conductive adhesive may comprise an anisotropic electrically conductive film or alternatively electrically conductive glue, such as an anisotropic conductive film.

The electrodes may each comprise an elongate metal electrode. This is a relatively simple yet effective construction, particularly as the metal electrodes may each comprise a metal strip or rod.

Alternatively, the electrodes may each comprise a flexible printed circuit. This is effective too, as is the case when the electrodes may each comprise a heat seal.

There is preferably a protective coating for the electrodes. This can encapsulate the electrodes and adhesive to provide a compact single unit, particularly when there is a protective and insulating coating for the electrodes. The circuit is thus electrically isolated except where electrical connection is required.

The coating may in a preferred embodiment comprise silicone.

There may be mechanical securing means to enhance electrical contact between the electrodes and the ITO surface, for example such mechanical securing means may comprise mechanical clips or clipping devices. This provides a positive electrical contact between the electrodes and ITO surface.

The adhesive may have electrically conductive beads incorporated therein.

According to a second aspect of the invention there is provided a liquid crystal display comprising a heater as hereinbefore defined.

The display may comprise a double STN (DSTN) display which may have a dummy cell adapted for optical compensation, an active cell, and two spaced apart polarisers which may incorporate the dummy cell and active cell therebetween. This is a particularly simple yet effective construction.

The substrate of the heater may comprise a transparent substrate of the dummy cell. This is an efficient use of the components and can

provide a compact construction.

The heater may comprise an upper (as viewed) substrate of the dummy cell, or alternatively the heater may comprise a lower (as viewed) substrate of the dummy cell.

Again, the heater may comprise upper and lower (as viewed) substrates of the dummy cell.

There may be transparent substrates of the dummy cell and heater laminated by a conductive perimeter adhesive. This again provides a compact structure, and the adhesive may comprise an epoxy resin, such as an epoxy resin and conductive spacers.

The epoxy resin may comprise a conductive epoxy of high resistivity.

The substrate of the heater may comprise glass. This is a relatively inexpensive yet efficient substrate material.

The heater may be in contact with the liquid crystal.

The electrodes may be connected with a source of electrical power, preferably an alternating voltage. This actuates the heater to warm up the display.

The heater may comprise an indium tin oxide (ITO) heater. This is particularly effective.

According to a third aspect of the invention there is provided a device including an LCD display as hereinbefore defined.

The device may be mounted in a vehicle, e.g. an automobile, although a lorry, truck, van, motorcycle, ship, boat or aircraft could utilise such a device.

The heater and a liquid crystal display (LCD) incorporating same are hereinafter described, by way of example, with reference to the accompanying drawings.

Fig. 1 is a plan view of a heater, in this case an indium tin oxide (ITO) heater, according to the invention;

Fig. 2 is a transverse cross-sectional view of the heater of Fig. 1;

Fig. 3 is, to a larger scale, a perspective view of part of the heater of Figs. 1 and 2;

Fig. 4 is a transverse cross-sectional view of a double STN (DSTN) liquid crystal display; and

Fig. 5 is a transverse cross-sectional view of the DSTN of Fig. 4 incorporating an ITO heater of Figs. 1 to 3.

Referring to the drawings, there is shown in Figs. 1 to 3 and 5 a heater 1 for electrical or electronic components such as liquid crystal displays (LCDs) such as the DSTN display 2 of Fig. 4, comprising a

substrate 3 to which is applied a layer 4 of transparent conductive material, in the embodiment illustrated indium tin oxide (ITO), and electrodes 5 secured electrically conductively thereto over the width thereof and extending therebeyond for connection with a source of power (not shown). Thus the electrodes 5 have extensions 6 for connection directly or by wires with a source of alternating applied voltage, in order to actuate the heater to produce heat.

The substrate is suitably of glass and transparent, according to an embodiment of the invention. Conductive transparent indium tin oxide (ITO) patterned or non-patterned is coated on the substrate. The two conductive electrodes (e.g. metal strip or rod, or flexible printed circuit) are then adhered on the conductive ITO surface. Conductive adhesives 7 (e.g. conventional anisotropic conductive film or conductive glues) are applied to the ITO surface. These adhesives 7 are normally cut in a long strip which are placed at the opposite margins of the substrate which is orthogonal, suitably rectangular. The width of the electrodes 5 is normally between 1.5mm and 4mm and the length is the width of the substrate 3 or the width of the ITO coating 4. These long electrodes can be covered by a protective and insulation substance 8 (e.g. silicone) to keep the joint from moisture. The conductive electrodes extend outside the substrate or are elongated by means of soldering with connecting wires to provide the extensions. The elongated portions of extensions 6 of the conductive electrodes 5 are connected to a voltage supply (either DC or AC, preferably square wave AC). When a voltage is applied, the ITO is heated up by means of resistive power dissipation.

The rate of heating up the display is dependent on the voltage and waveform applied to the conductive electrodes of the ITO heater. The "warm up" time for bringing the temperature to that desired is shortened when the voltage (and therefore the power) of the ITO surface is increased or the resistance of the ITO is decreased. On the other hand, there is an intrinsic limitation of the maximum current through the electrodes, conductive adhesives and the ITO film. This limiting value is dependent on the area of the conductive adhesives and the critical current density (determined by the density of conductive beads inside the conductive adhesives) for the current flowing from one electrode to the ITO surface.

Referring now to Fig. 4, there is shown a typical double STN (DSTN) liquid crystal display 2. This comprises, typically top and bottom polarisers 9, 10 and sandwiched therebetween a dummy cell 11 and an active cell 12 each comprising a pair of transparent substrates 13 with a liquid crystal layer 14 therebetween.

A majority of applications of a DSTN is in the dashboards or consoles of automotives. The cold environment of the automotives greatly reduces the optical performance and increases response time of the liquid crystal displays. Because of this temperature dependence, the display is best maintained at a suitable temperature.

In the invention, this is achieved by incorporating an internal ITO heater to keep the display at a suitable temperature. For DSTN displays, one of the transparent substrates of the dummy cell is used as an ITO heater, see Fig. 5 in this case, when the ITO heater is ON,

there may be some potential difference between the ITO of the upper substrate and the lower substrate of the dummy cell. This may deteriorate the optical compensation of the dummy cell. This phenomenon is called "false triggering". Conductive epoxy or epoxy blended with some conductive spacers is used for this dummy cell where the ITO heater sits. This conductive perimeter epoxy equalizes the potential of the two transparent substrates so as to minimize the occurrence of false triggering. It is also used to maintain a uniform desired cell gap. There are two main points to secure the use of the dummy cell as the heating element. The first one is the conductive adhesive between the electrode and the ITO surface which determines the maximum current. The second one is the conductive perimeter epoxy between the two glass substrates of the dummy cell, which eliminates false triggering and improves resistance to EMI. To ensure the heating current flow mainly on the ITO heater coating, the sheet resistivity of the ITO coating on the other substrate is selected to be much bigger than that of the ITO heater. A ratio of more than 10:1 is appropriate. This arrangement also ensures no chance of open circuit between the ITO electrodes because of large current flowing through the conductive spacers. To shorten the "warm up" time, a larger power dissipated from the ITO heater is required. It needs a larger affordable current in the ITO heater. When the contact area or the critical current density of the conductive adhesive is increased, the affordable current is increased. For the conductive epoxy, one can increase conductive spacer density in the epoxy or use asymmetric resistivities. That means, one of the substrates has a large ITO resistivity so that the current flowing through the conductive epoxy is much reduced. After the display is

heated up to the desired temperature, a smaller power is required in balancing the heat loss due to cooling the environment.

Thus in an ITO heater 1 and DSTN display 2 as described hereinbefore with reference to the accompanying drawings, the ITO heater consists of a (patterned or non-patterned) transparent ITO layer coated on a substrate (e.g. glass substrate), a pair of conductive electrodes (e.g. metal strips or rods, or flexible printed circuit) that is adhered to the ITO surface by some conductive adhesives e.g. anisotropic conductive film (ACF) or conductive glues. These conductive electrodes are connected to a voltage supply directly or via some metal wires. The exposed conductive electrodes can be covered by some protective and insulating material such as silicone. The advantage of using conductive adhesives in connecting the conductive electrodes on the ITO surface over using clips for electrical conduction on the ITO surface is that the former method has better adhesion, less ohmic drop and, more importantly the electric current density on the ITO surface is more uniform over the whole contacting area. This is especially important for the case of double STN (DSTN) where the heater is normally put on either one of the interior surfaces or both of the dummy cell. This ensures that the current flux is below some threshold value, resulting in no false triggering of deteriorated optical compensation. The mechanical adhesion between the electrodes on the ITO surface can be strengthened by additional clipping. Usually an alternating voltage is applied to the ITO heater to heat up the display.

The "warm up" time needed to bring the temperature up to a desired

level is mainly dependent on the applied voltage and waveform, the resistance of the ITO heater, the mass of the transparent substrate, the temperature difference between the display and the surrounding. The shorter the warm up time, the larger the power needed. However, the current should not exceed a certain threshold value. This limiting current value is mainly determined by the maximum tolerable loading of the conductive adhesives. As a consequence, there is a minimum warm up time in raising a certain temperature for a given ITO resistivity.

A more detailed description, even though the invention can be applied to general cases, is illustrated in the case of double STN (abbreviated as DSTN) configuration applied to automotives. A DSTN is made up of two polarisers, two liquid crystal layers with four transparent substrates (two transparent substrates and one liquid crystal layer forming the active layer acting for light modulation and the other two transparent substrates and one liquid crystal layer forming the dummy layer acting for optical compensation). A schematic is found in Fig. 4. When the ITO heater is incorporated into the DSTN display, some slight adjustment in the substrate size and ITO resistivity has to be considered. A schematic is found in Fig. 5. The dummy cell acts as light compensation and the active cell is a light modulating mechanism.

It will be understood too that the glue used to connect the electrodes physically and electrically shorted to the ITO surface can be any effective conductive glue other than anisotropic conductive film (ACF). Also, the electrodes may be located at any suitable position

on the ITO surface other than at the edges as illustrated. Thus they may be located at two opposite shorter or two opposite longer edges of a rectangular substrate. Resistive heat is generated in the ITO surface, the power being dependent on the resistance of the ITO heater and the voltage and waveform supplied across the electrodes of the ITO heater. The resistivities of the ITO surface of a DSTN dummy cell are suitably chosen so that the current flowing from one transparent substrate of the dummy cell to the other transparent substrate is safe and below the critical value tolerable to the conductive perimeter epoxy. Moreover, the conductive adhesives of the ITO heater are selected so that current flowing from a conductive electrode of the ITO to the ITO surface is safe and tolerable to the conductive adhesive. This is to ensure the structural integrity of the heater, and DSTN device, in use. The dimension of the substrate is adjusted to allow for placement of the electrodes 5.

Protective and insulating materials are used to cover and protect the conductive electrodes of the ITO heater. When used with a DSTN display such a display does not evidence false triggering in optical compensation when the ITO heater is turned on, and moreover such a display shows improved resistance to EMI.

It will be understood too that a heater according to the invention may be placed on any surface of an LCD, e.g. inside or outside, whether in contact with the liquid crystal layer or not.

CLAIMS

1. A heater for electrical or electronic components, comprising a substrate to which is applied a layer of transparent conductive material and electrodes secured electrically conductively thereto over the width thereof and extending therebeyond for connection with a source of power.

2. A heater according to Claim 1, the conductive material comprising a layer of indium tin oxide (ITO) applied to the substrate, which is orthogonal.

3. A heater according to Claim 2, there being two electrodes one at a respective opposite side of the layer and secured thereto by a conductive adhesive.

4. A heater according to Claim 3, the conductive adhesive comprising an anisotropic electrically conductive film.

5. A heater according to Claim 3, the conductive adhesive comprising electrically conductive glue, such as an anisotropic conductive film.

6. A heater according to any of Claims 3 to 5, the electrodes each comprising an elongate metal electrode.

7. A heater according to Claim 6, the metal electrodes each comprising a metal strip or rod.

8. A heater according to any of Claims 3 to 5, the electrodes each comprising a flexible printed circuit.

9. A heater according to any of Claims 3 to 5, the electrodes each comprising a heat seal.

10. A heater according to any preceding claim, comprising a protective coating for the electrodes.

11. A heater according to Claim 10, comprising a protective and insulating coating for the electrodes.

12. A heater according to Claim 11, the coating comprising silicone.

13. A heater according to any of Claims 2 to 12, comprising mechanical securing means to enhance electrical contact between the electrodes and the ITO surface.

14. A heater according to Claim 13, the mechanical securing means comprising mechanical clips or clipping devices.

15. A heater according to any of Claims 3 to 14, the adhesive having electronically conductive beads incorporated therein.

16. A heater for electrical or electronic components, substantially as hereinbefore described with reference to the accompanying drawings.

17. A liquid crystal display, comprising a heater according to any preceding claim.

18. A display according to Claim 17, comprising a double STN (DSTN) display having a dummy cell adapted for optical compensation, an active cell, and two spaced apart polarisers incorporating the dummy cell and active cell therebetween.

19. A display according to Claim 18, the substrate of the heater comprising a transparent substrate of the dummy cell.

20. A display according to Claim 19, the heater comprising an upper (as viewed) substrate of the dummy cell.

21. A display according to Claim 19, the heater comprising a lower (as viewed) substrate of the dummy cell.

22. A display according to Claim 19, the heater comprising upper and lower (as viewed) substrates of the dummy cell.

23. A display according to Claim 22, transparent substrates of the dummy cell and heater being laminated by a conductive perimeter adhesive.

24. A display according to Claim 23, the adhesive comprising an epoxy resin.

25. A display according to Claim 24, the adhesive comprising an

epoxy resin and conductive spacers.

26. A display according to Claim 24, the epoxy resin comprising a conductive epoxy of high resistivity.

27. A display according to any of Claims 17 to 26, the substrate of the heater comprising glass.

28. A display according to any of Claims 17 to 27, the heater being in contact with the liquid crystal.

29. A display according to any of Claims 17 to 28, the electrodes being connected with a source of electrical power.

30. A display according to any of Claims 17 to 29, the heater comprising an indium tin oxide (ITO) heater.

31. A liquid crystal display, substantially as hereinbefore described with reference to the accompanying drawings.

32. A device including an LCD display according to any of Claims 17 to 31.

33. A device according to Claim 32, mounted in a vehicle, e.g. an automobile.

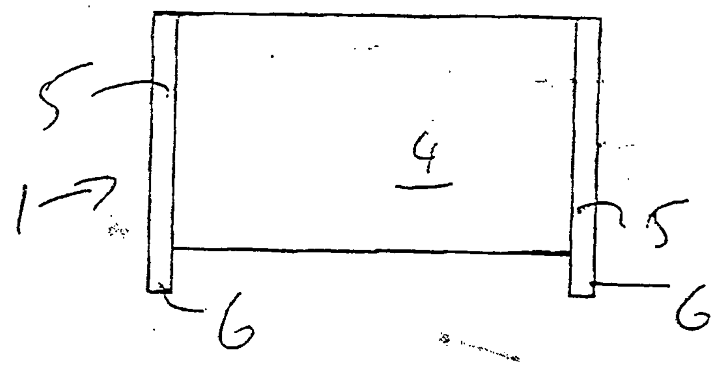

FIG. 1

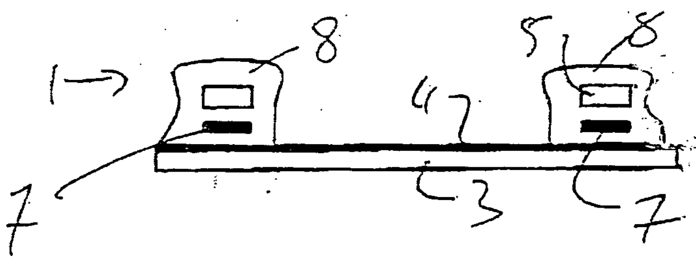

FIG. 2.

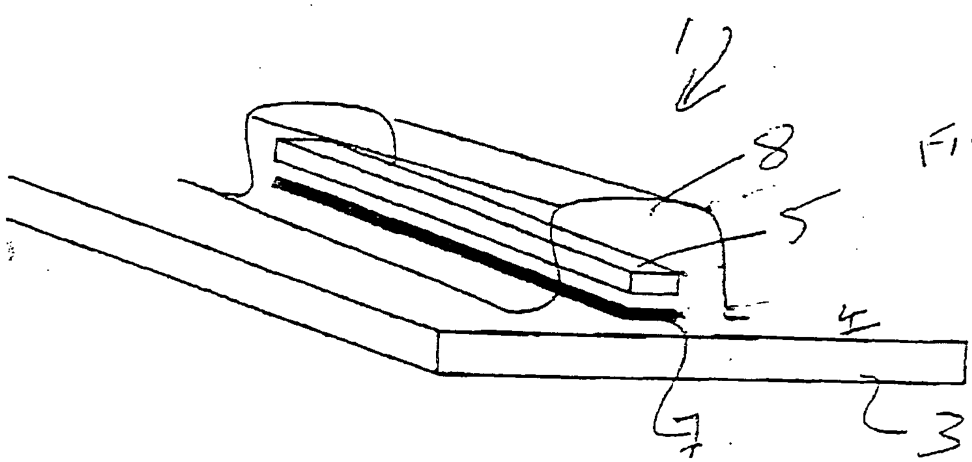

FIG. 3

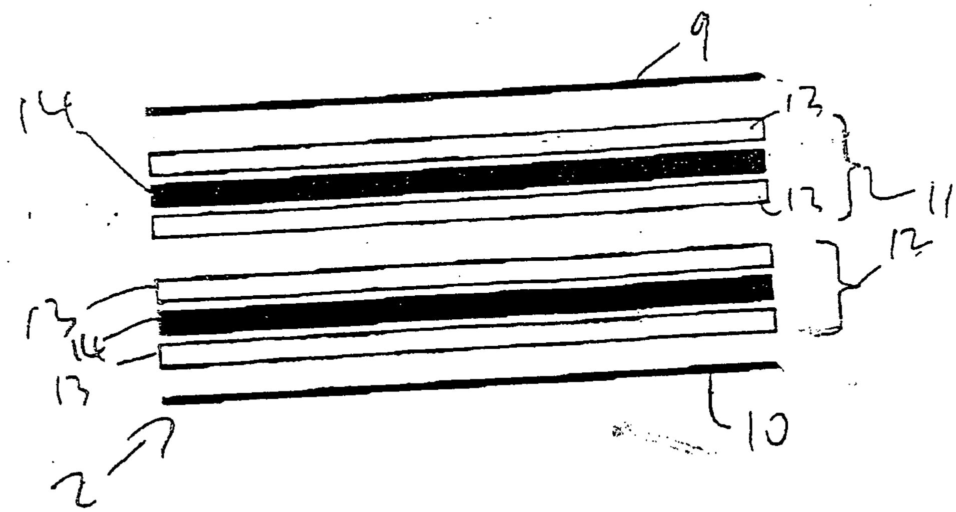

FIG. 4

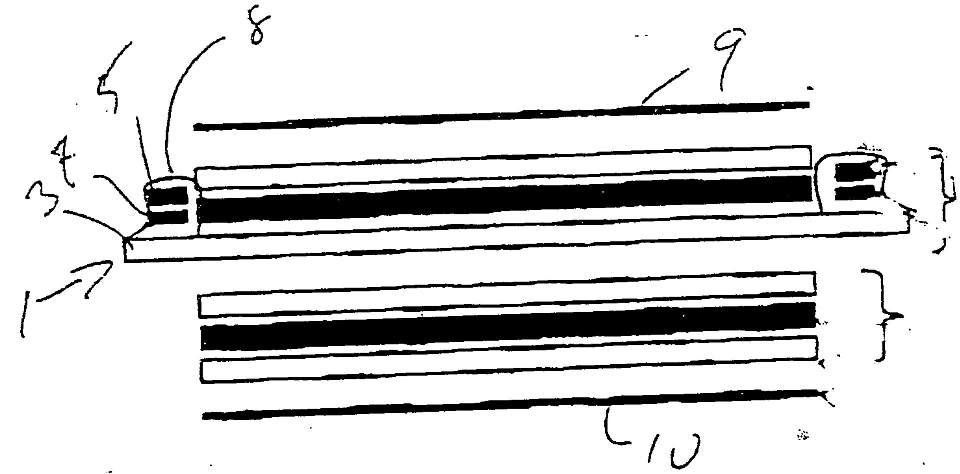

FIG. 5